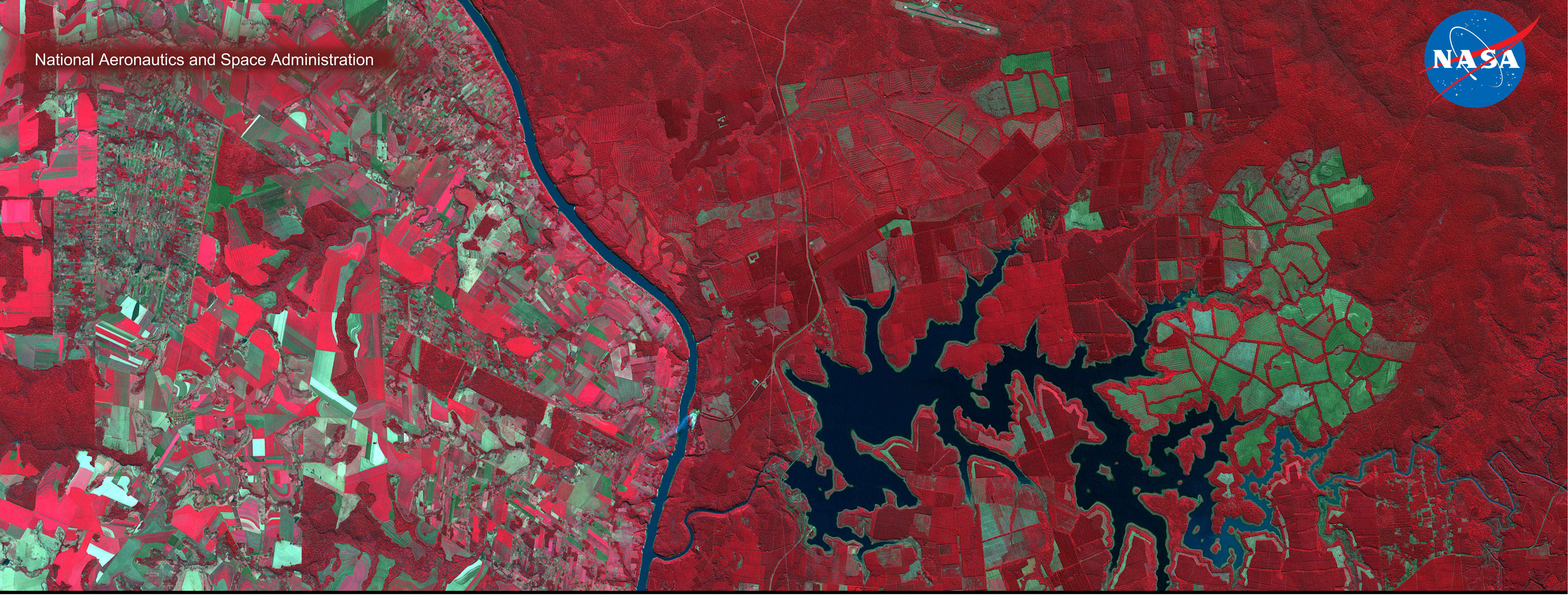


# Generation of an Interferogram – Earthquake Deformation

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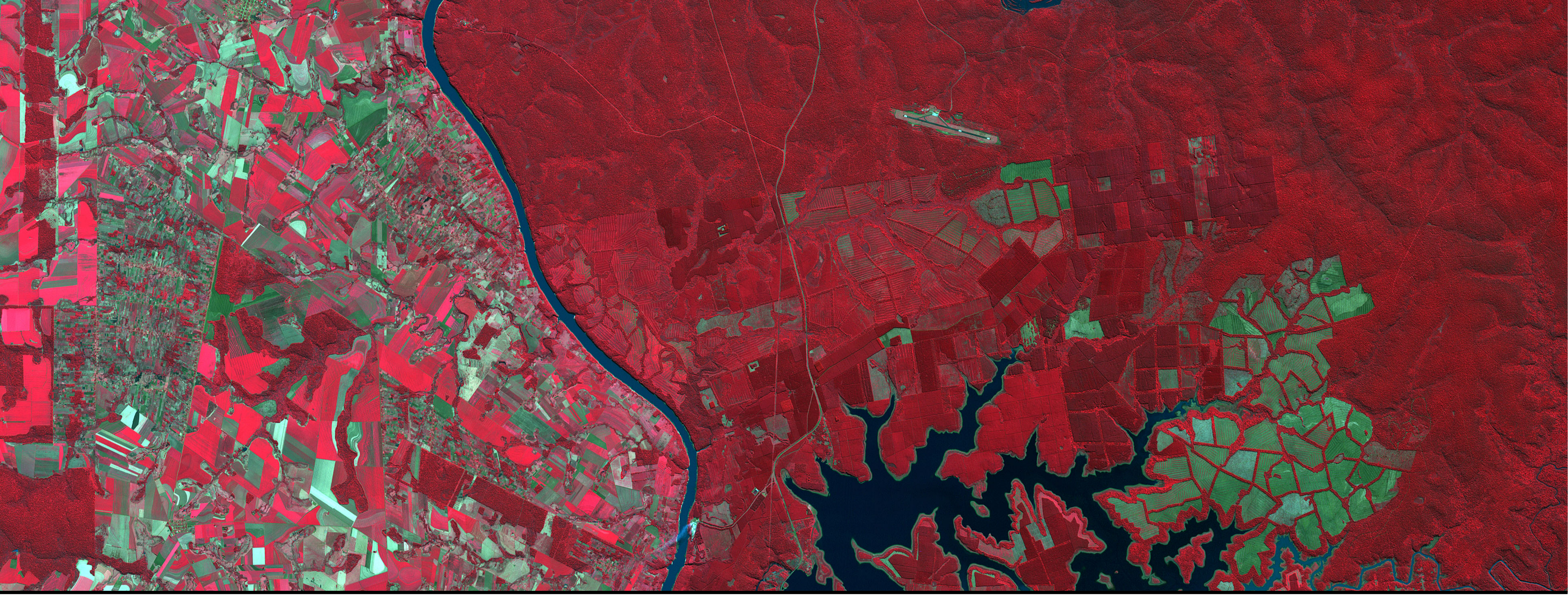
# Objectives

By the end of this exercise, you will be able to understand the steps needed to create an interferogram

# Outline

- Part 1: Accessing, Opening, and Displaying SAR Data for Generating an Interferogram
- Part 2: Preprocessing



# Accessing, Opening, and Displaying SAR Data for Generating an Interferogram

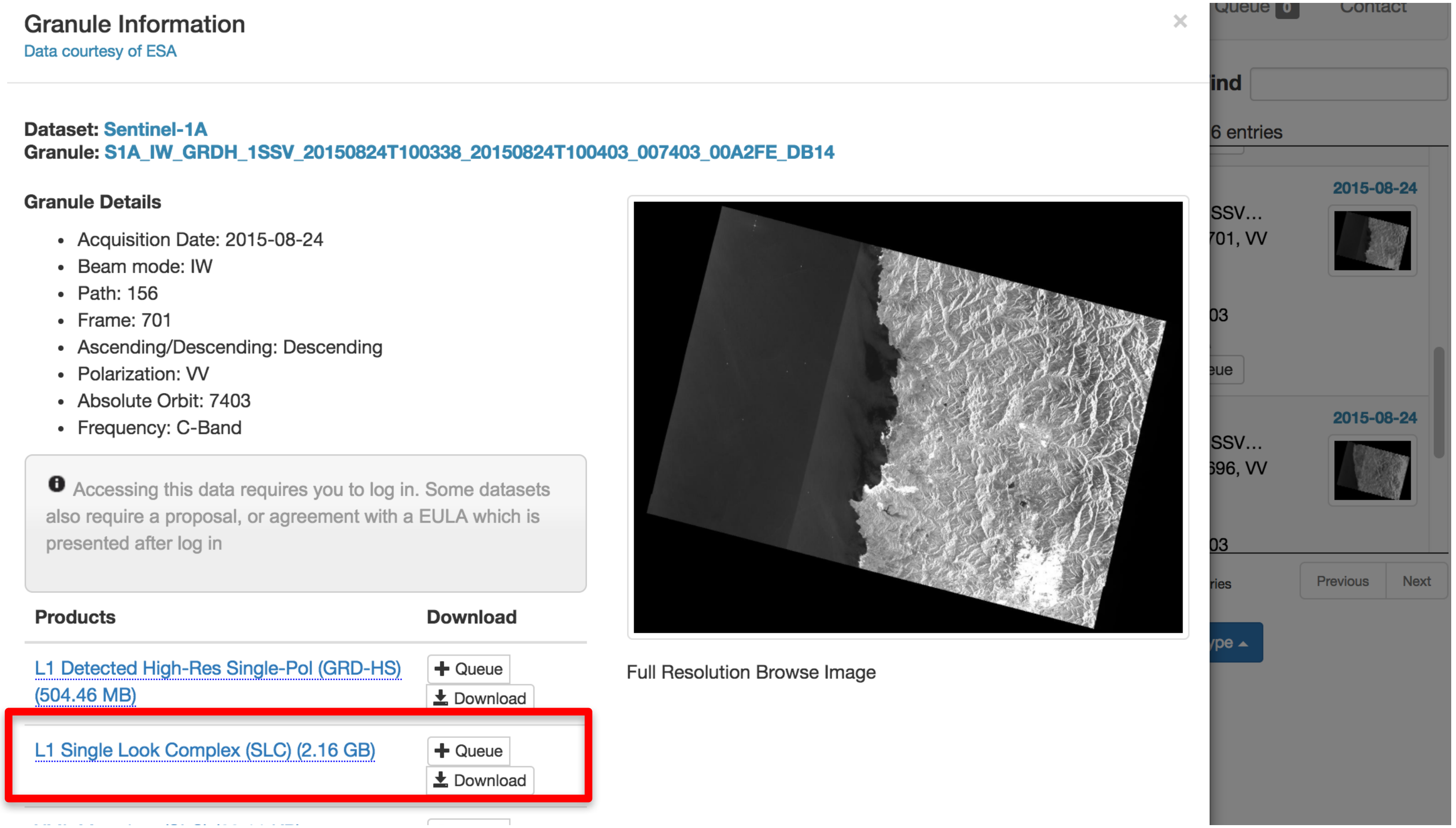
# Accessing Sentinel-1 Data for Interferometry

The area of interest is in Chile, where the Illapel Earthquake took place (Magnitude 8.3)

1. Go to the Alaska Satellite Facility Sentinel Data Portal:
   – https://vertex.daac.asf.alaska.edu/
2. Identify the area of interest (**-72**, **-30**, **-72**, **-32**,**-71**,**-32**, **-71**, **-30**, **-72**, **-30**)
3. Identify the dates representing before (**Aug 24**, **2015**) and after (**Sep 17, 2015**) the event
4. Identify images of interest: **Sentinel-1 A/B**
5. Select **path 156**
6. Click **Search**

# Accessing Sentinel-1 Data for Interferometry

7. Select Granules:
   – S1A_IW_GRDH_1SSV_20150824T100338_20150824T100403_007403_00A2FE_DB14 (Frame 701)
   – S1A_IW_GRDH_1SSV_20150917T100339_20150917T100404_007753_00AC77_47FF
8. Download the **L1 Single Look Complex (SLC) (2.16 GB) Product**



# Opening the Data with the Sentinel Toolbox

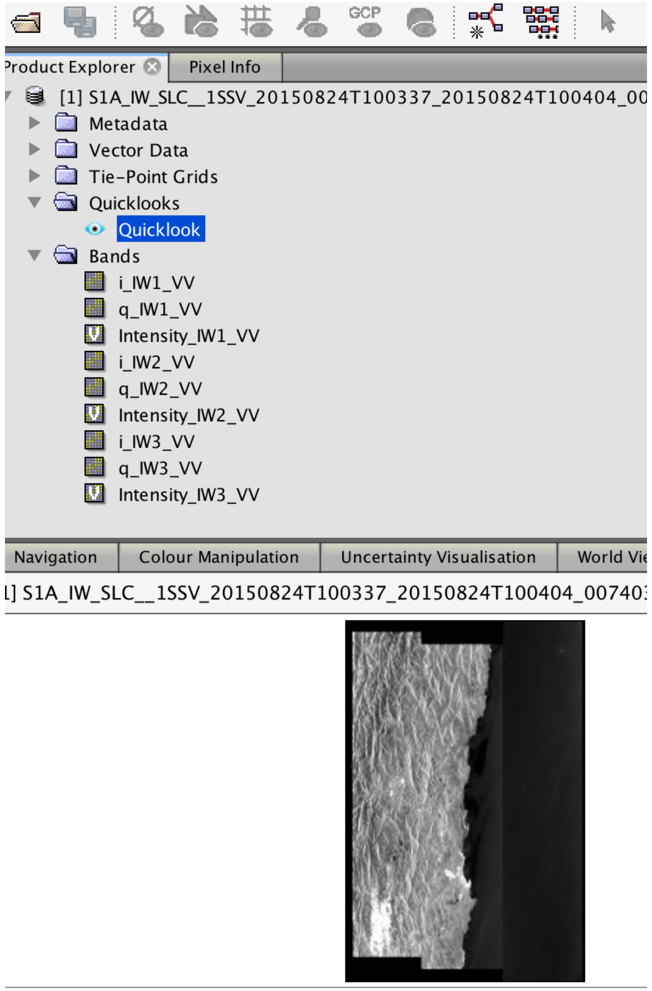
## Using the Same Toolbox as for SAR Amplitude Analysis

1. Initiate the Sentinel Toolbox (SNAP) by clicking on its desktop icon
2. In the Sentinel Toolbox interface, go to the **File** menu, and select **Open Product**
3. Select the folder containing your Sentinel-1 SLC file, and double click on the **.zip** file (do not unzip the file – the program will do it for you)

# Opening the Data with the Sentinel Toolbox

## SLC data has a different format

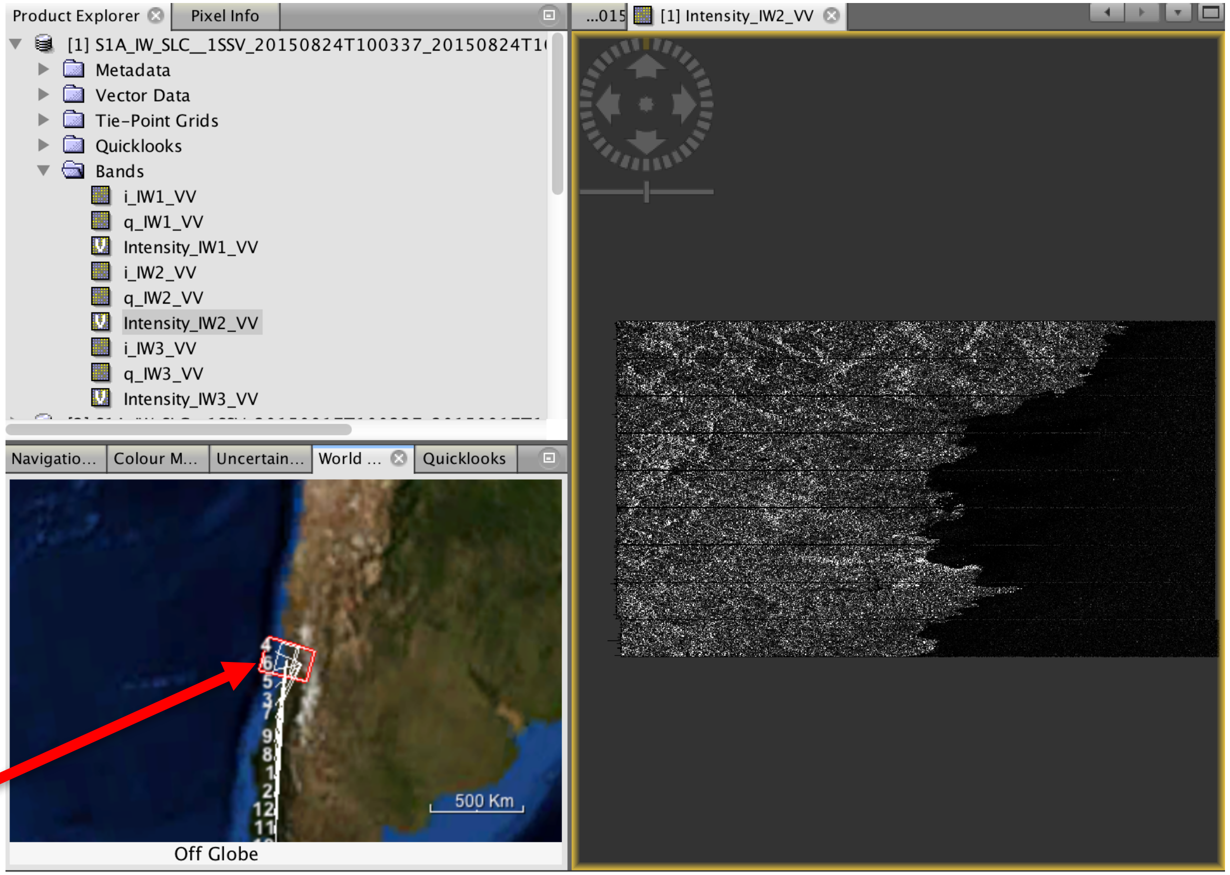
4. The Product Explorer window of the Sentinel Toolbox contains your file. Double click on the file to view the directories within the file, which contain information relevant to the image, including:
   - Metadata: parameters related to orbit data
   - Tie Point Grids: interpolation of latitude/longitude, incidence angle, etc.
   - Quicklooks: viewable images of whole scene in radar coordinates
   - Bands: complex values for each subswath “i” and “q” and intensity (intensity is the amplitude squared – a virtual band)

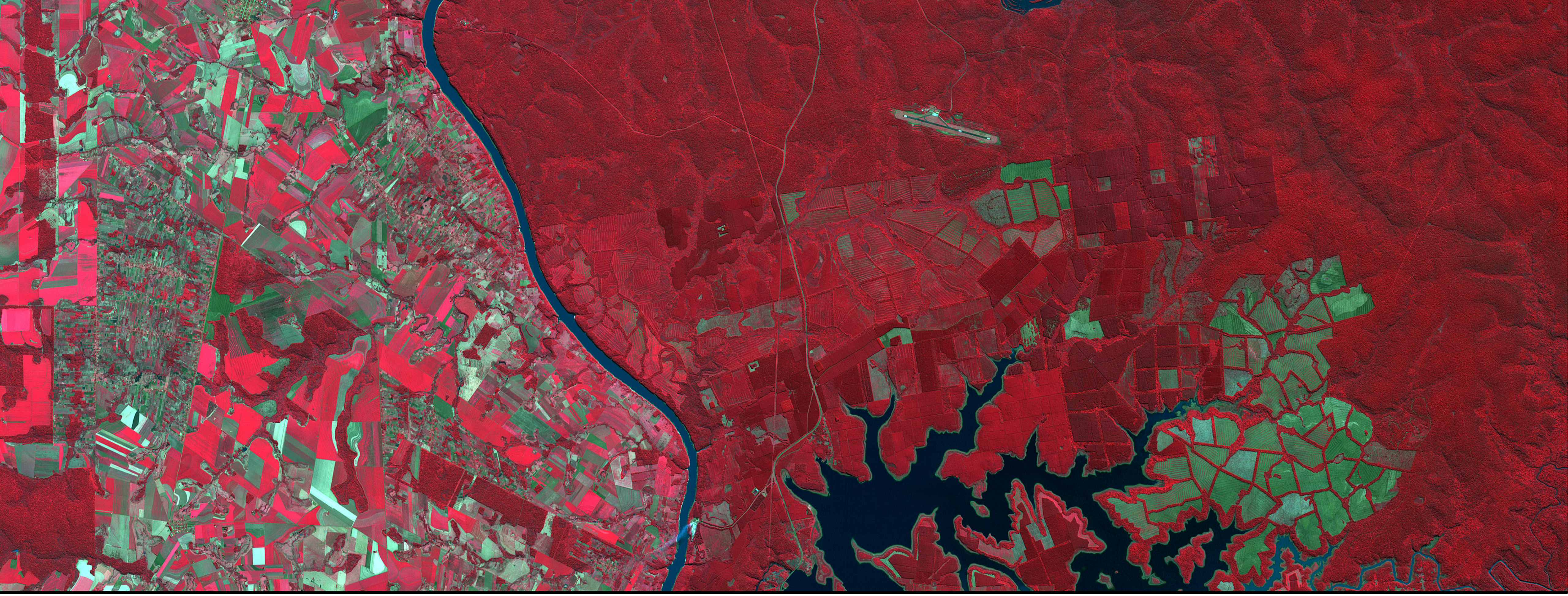


# Opening the Data with the Sentinel Toolbox

## Viewing the Subswath Image

5. The Worldview image on the lower left shows the footprint of the selected image
   – Note: the image is flipped east-west because it is oriented the same way it was acquired
6. Note that there are 3 subswaths. Display each image to verify that they look correct. We will only work with the one displayed on the right

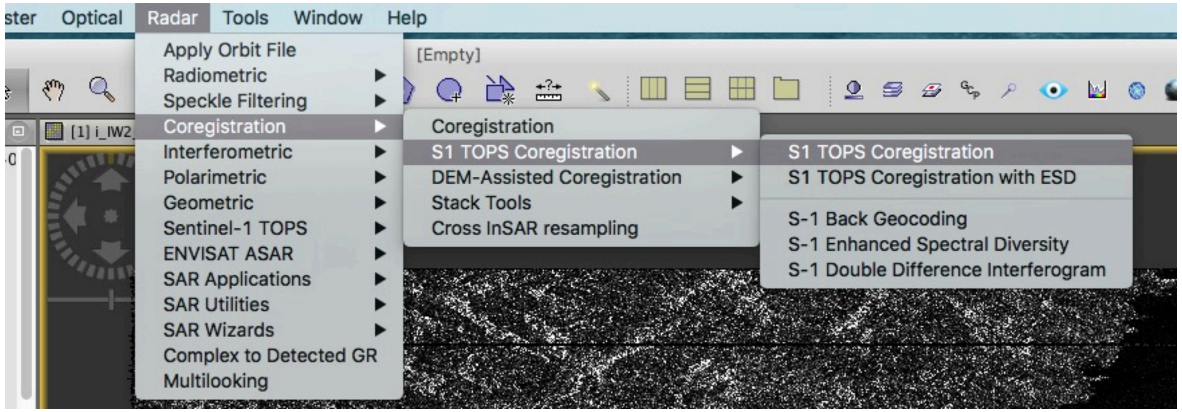


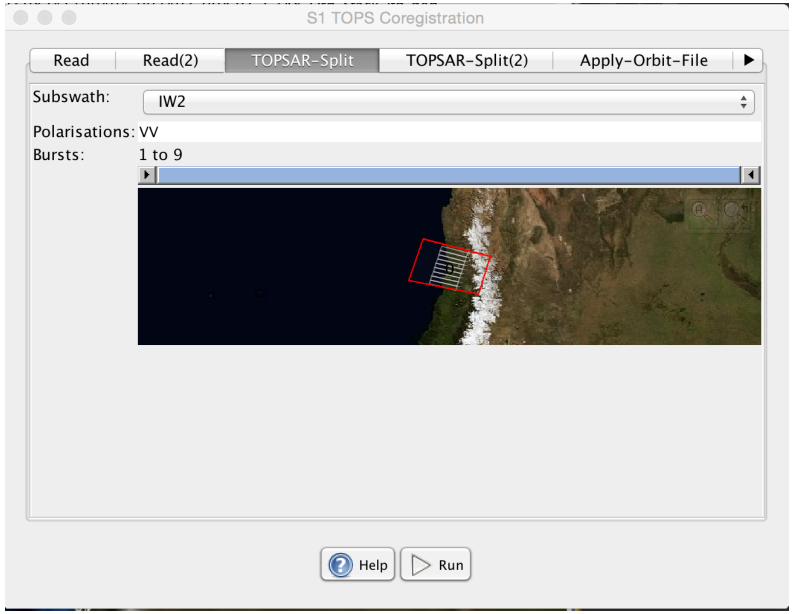


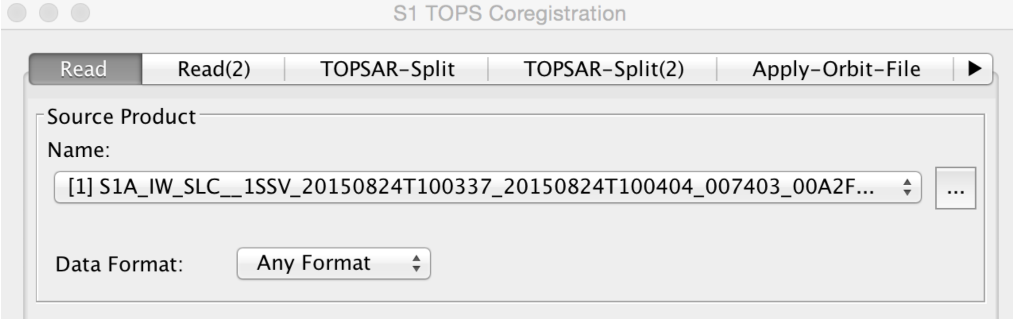
# Preprocessing

# Interferometry Data Preparation: Coregistering the Scenes

1. The first step of interferometry is to coregister the two SLC images
2. From the top menu, select **Radar** > **Coregistration** > **S1 TOPS Coregistration** > **S1 TOPS Coregistration**
3. In the **Read** tab, select the 20150824 SLC and in the **Read(2)** tab, select 20150917 SLC



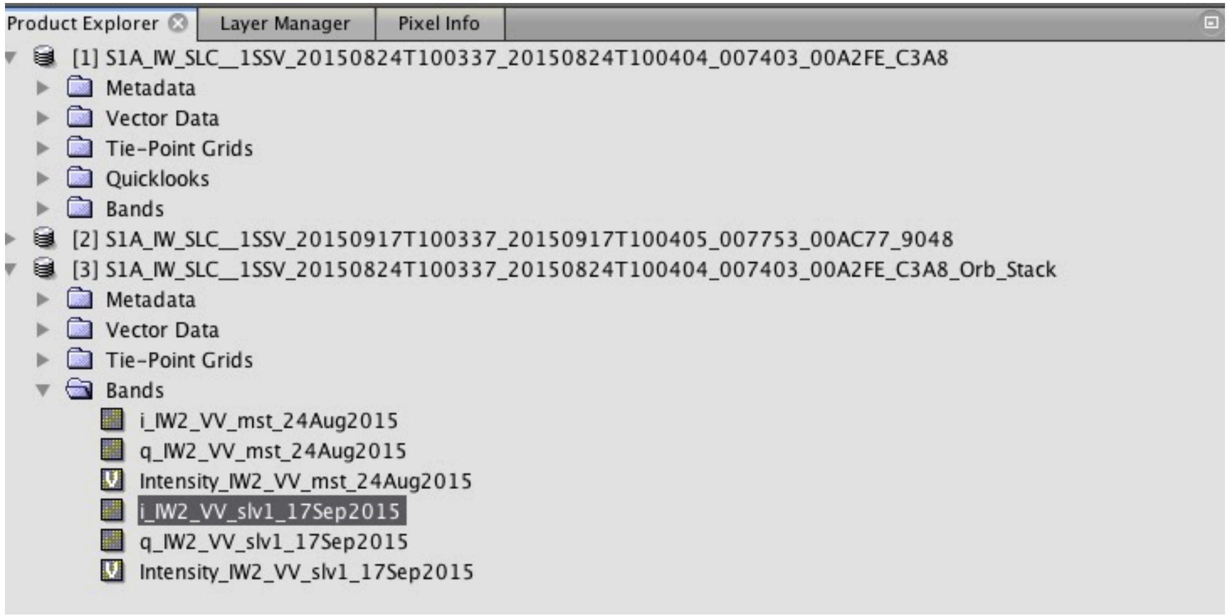
# Interferometry Data Preparation: Coregistering the Scenes

4. Only one subswath can be processed at a time. In the **TOPSAR-Split** and **TOPSAR-Split(2)**, select **Subswath IW2**.
   – Select **all bursts** and **VV**, since there is only one polarization
5. The **Apply Orbit** file tabs should be left as default
6. The back geocoding specifies the DEM to be used for processing the data - use the default
7. The **Write** tab specifies the output file. Use the default. The coregistered filename will have orb_stack at the end
8. Press **Run**

# Interferometry Data Preparation: Coregistering the Scenes

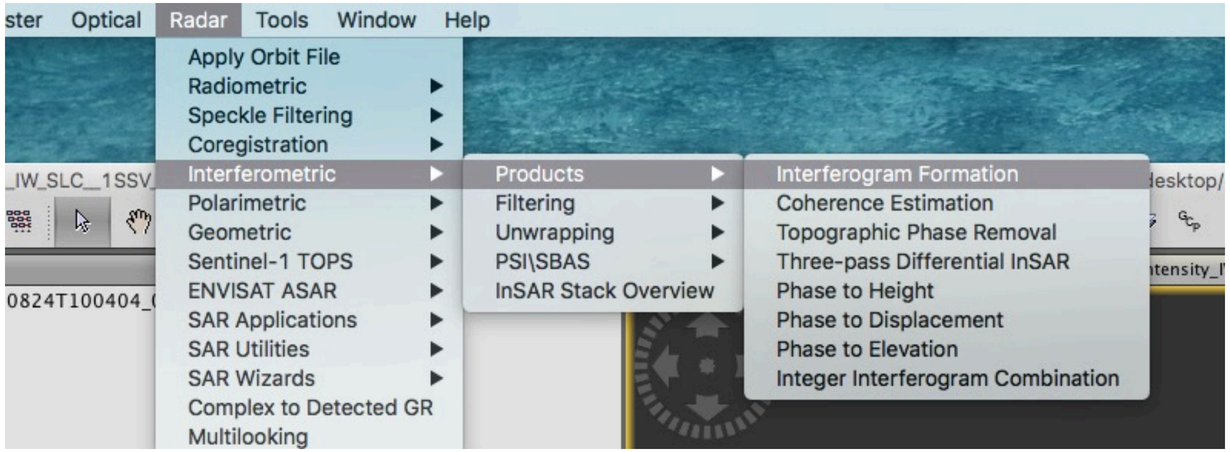
9. The resulting image now has Aug 24 and Sep 17 coregistered

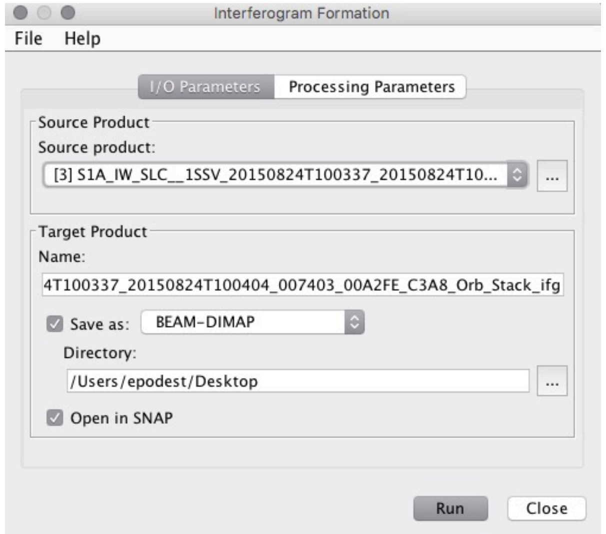
- Note that in addition to the intensity image (square of the complex number), there are also still imaginary (q) and real (i) images for each scene

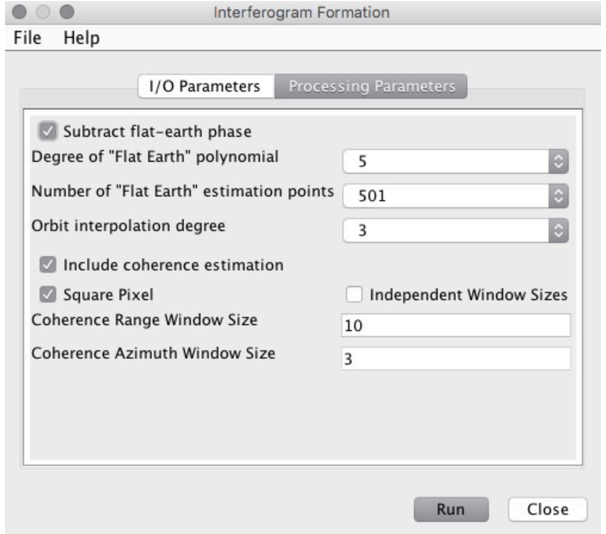


# Interferogram Formation

1. To make an interferogram go to the main menu bar and select **Radar** > **Interferometric** > **Products** > **Interferogram Formation**
2. In the I/O Parameters tab, set your Source product to be the coregistered file. The target product is the output filename, which will have ifg at the end
3. In the **Processing Parameters** tab, use the defaults
4. Click **Run**

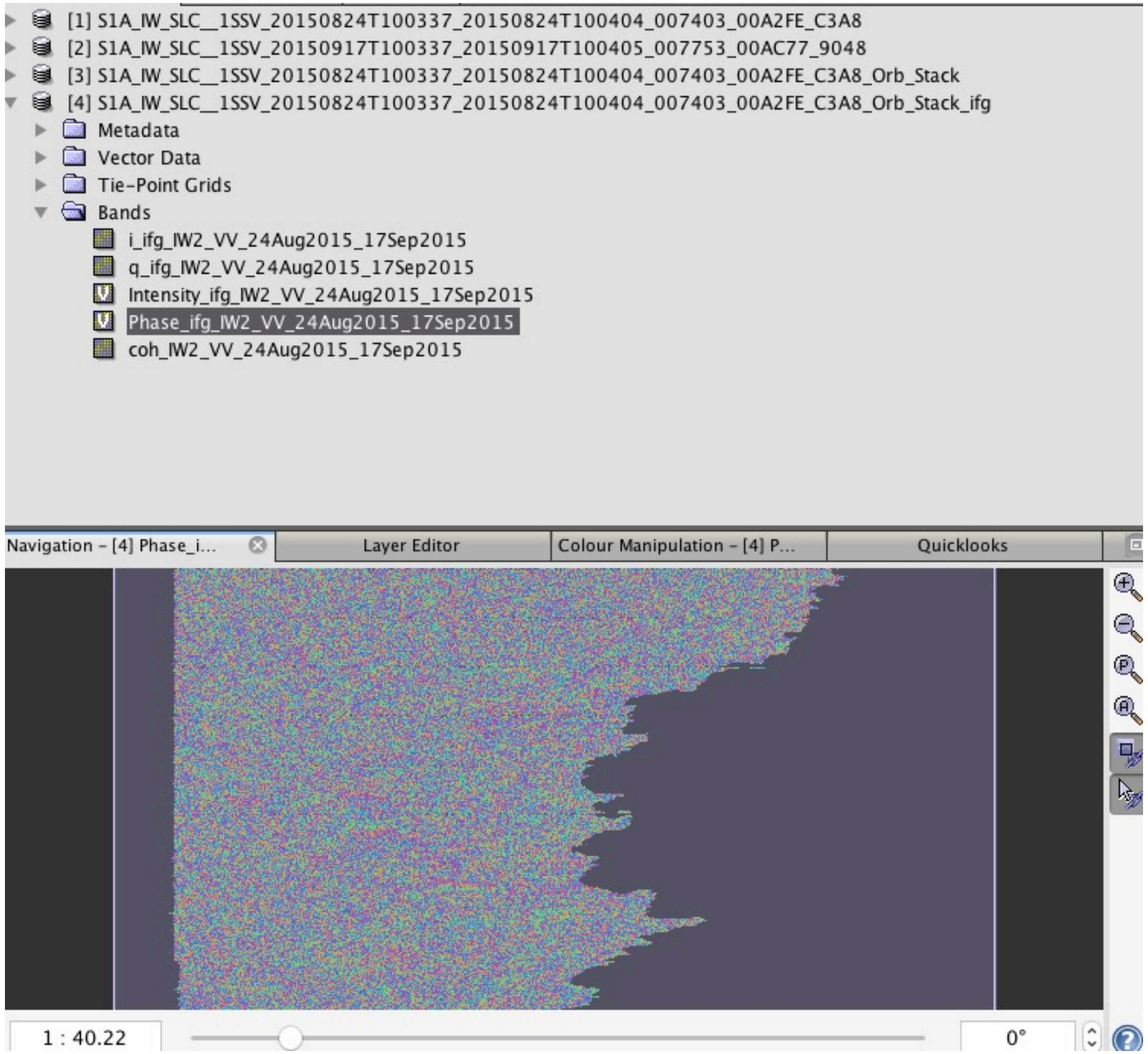


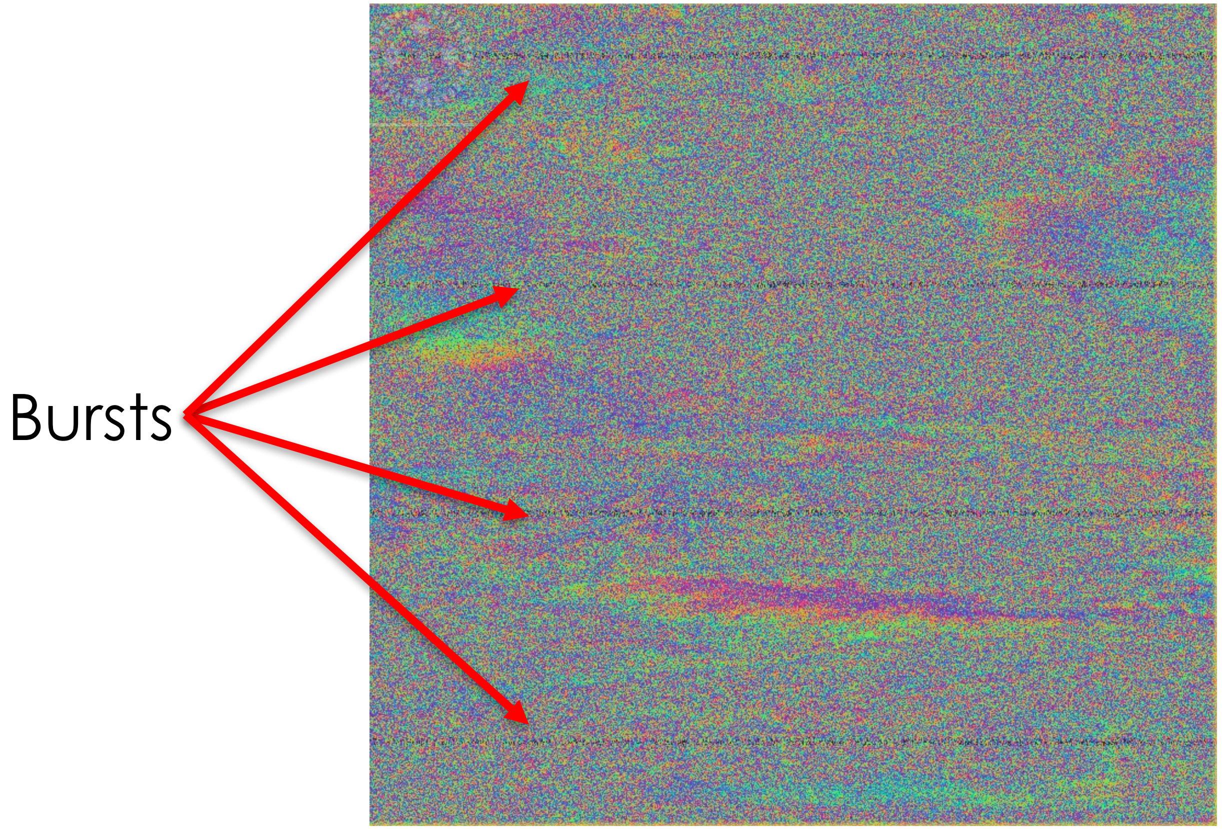
# Interferogram Formation

5. Display the results – the intensity, the phase, and the coherence image
6. Imaginary and real images are still present because the interferogram is still a complex interferogram (wrapped interferogram)
7. The intensity is the average of the two intensities



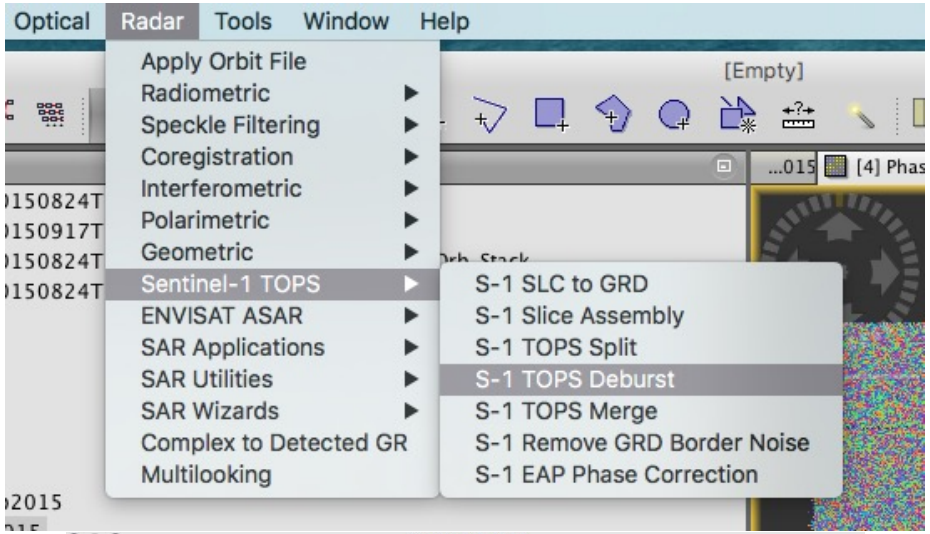
# Interferogram Formation

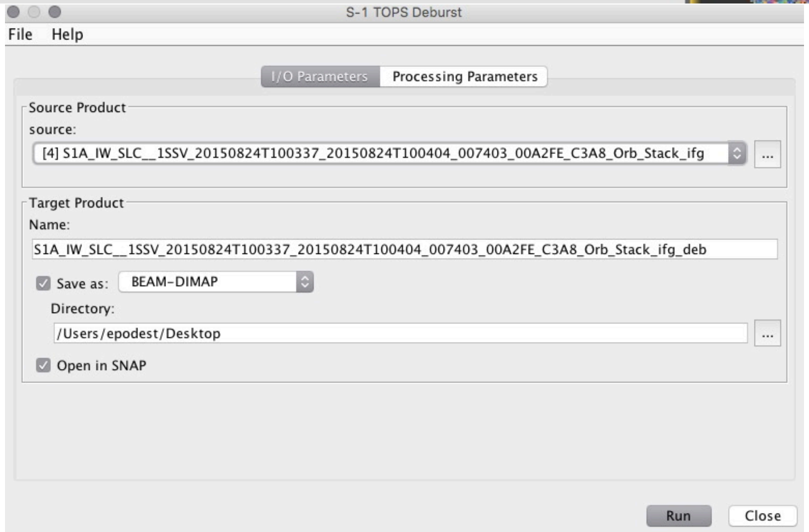
8. The phase is a mixture of the topographic phase and surface deformation phase
9. Note that the interferogram contains the original bursts (fine lines on the image)
10. For the rest of the processing, we will combine the bursts into one continuous image



# Debursting

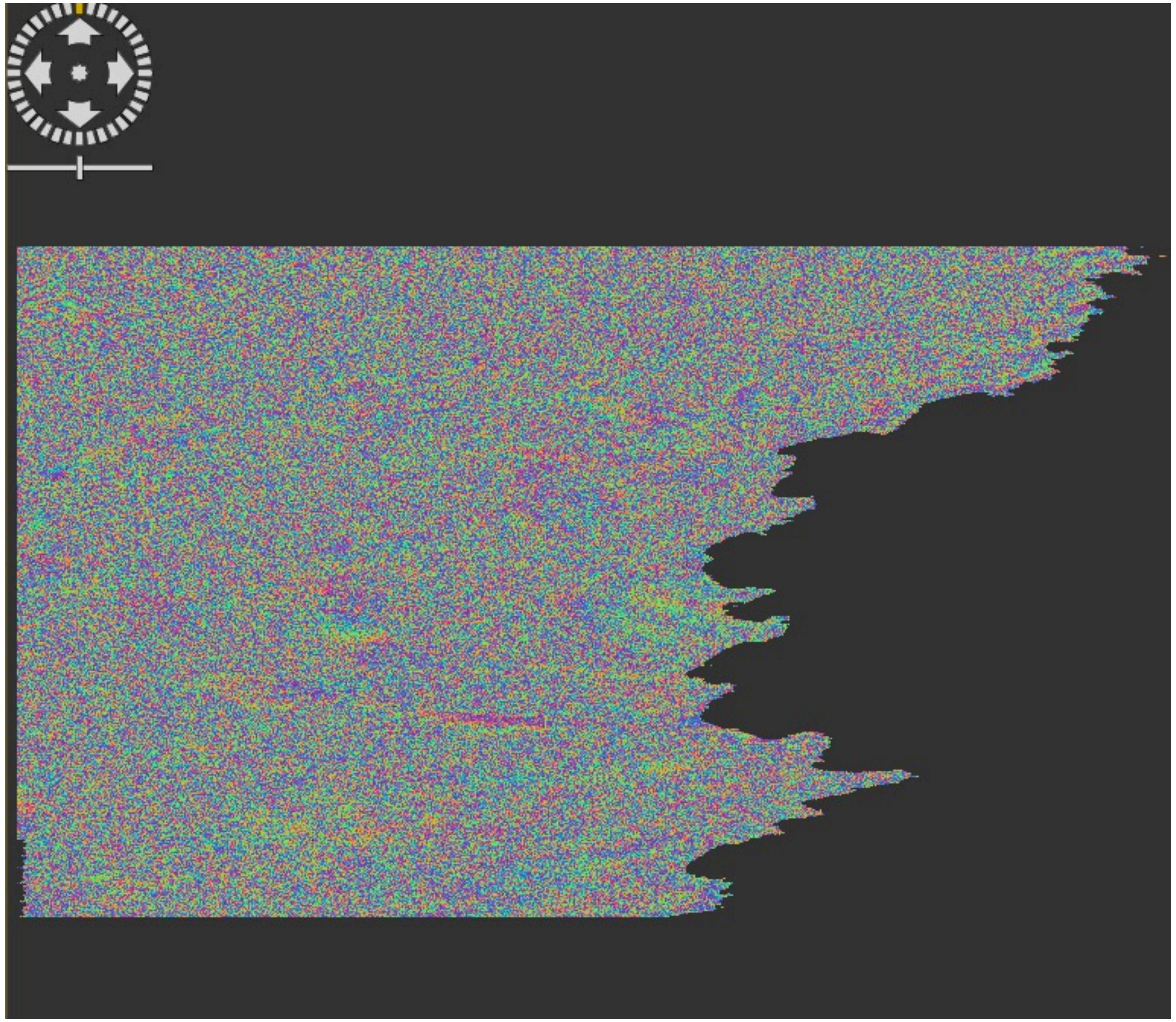
1. To deburst the image, go to the main menu bar and select **Radar** > **Setinel-1 TOPS** > **Sentinel-1 TOPS Deburst**
2. In the I/O Parameters tab, select the source as the _ifg file. The target product is the output file name, which will have _deb at the end
3. In the **Processing Parameters** tab, use the defaults
4. Press **Run**



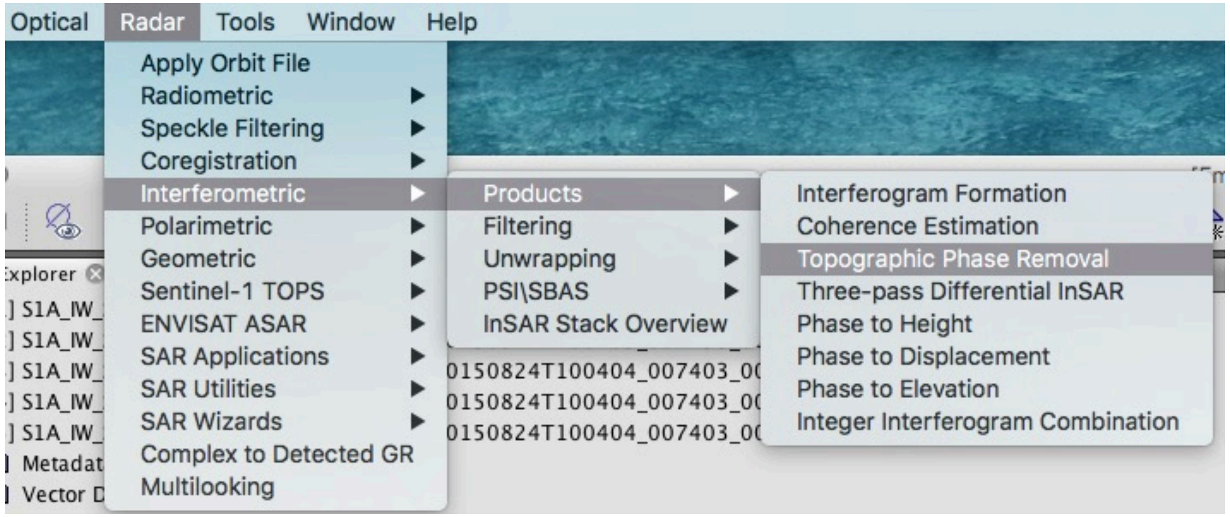
# Debursting

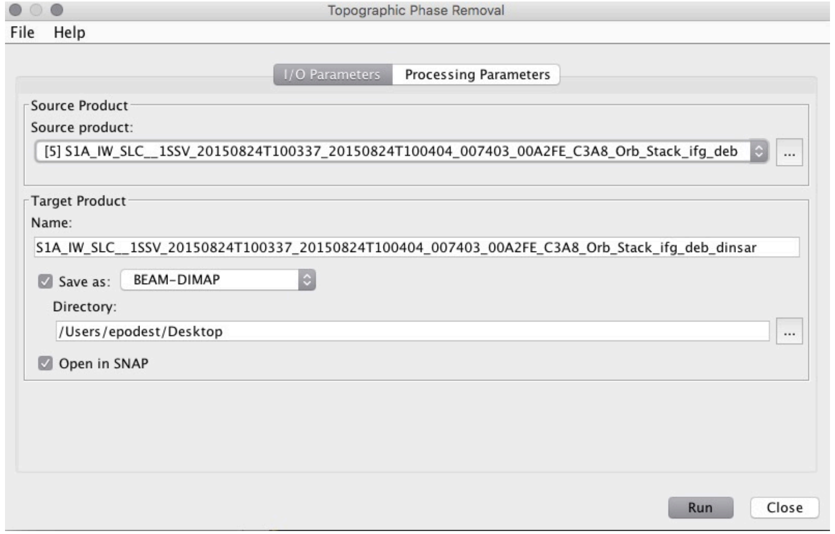
5. Display the image. The phase will look very similar, but note that the fine lines in the image are now gone because the bursts have been mosaicked together



# Differential Interferometry

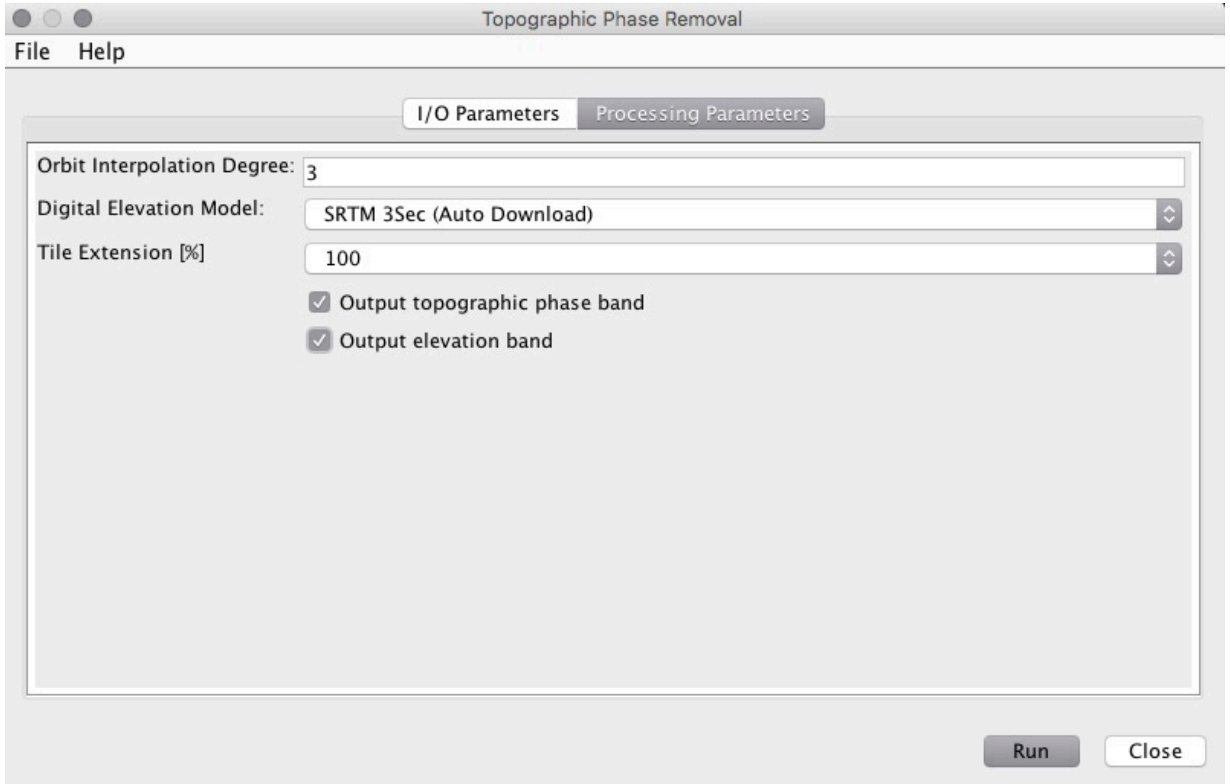
1. Calculate the phase due to topography by using a DEM. Go to the main menu, and select **Radar** > **Interferometric** > **Products** > **Topographic Phase Removal**
2. In the **I/O Parameters** tab, select the source as the _deb file. The target product is the output filename, which will have _dinsar at the end



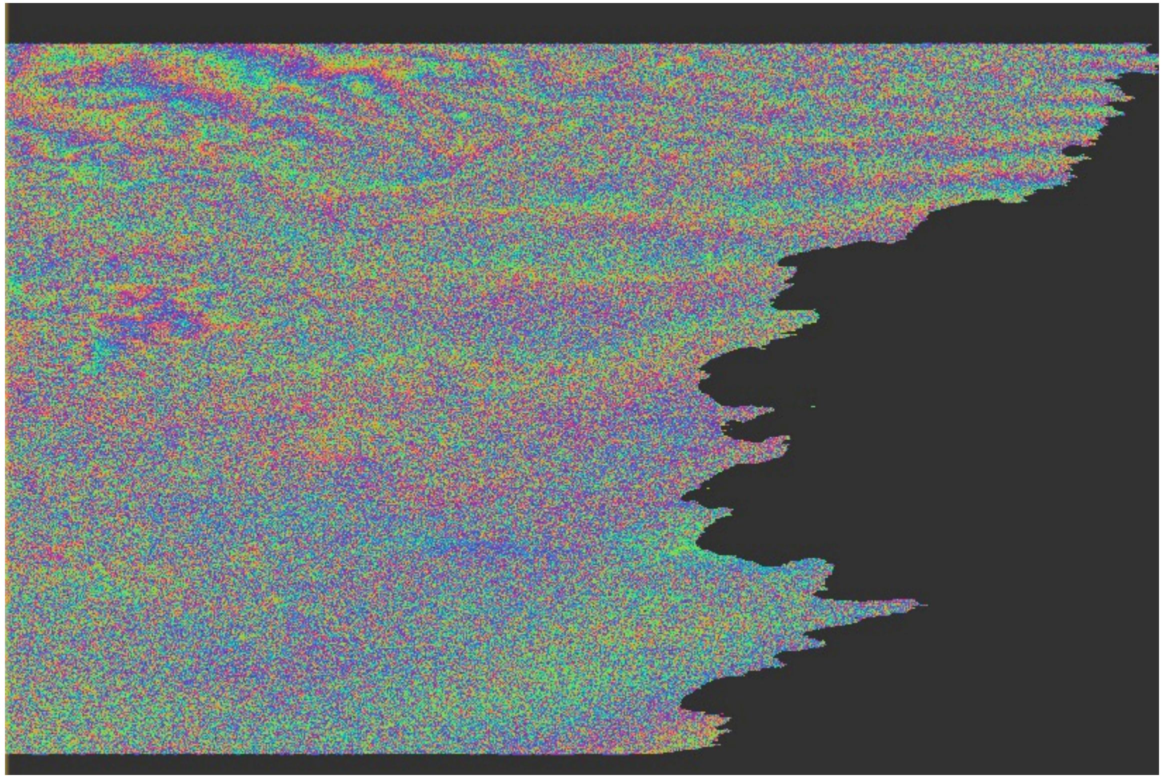
# Differential Interferometry

3. In the **Processing Parameters** tab, specify the DEM that will be used. In this case, use the default. Select the topographic phase band and elevation band to create the output bands.
4. Press **Run**



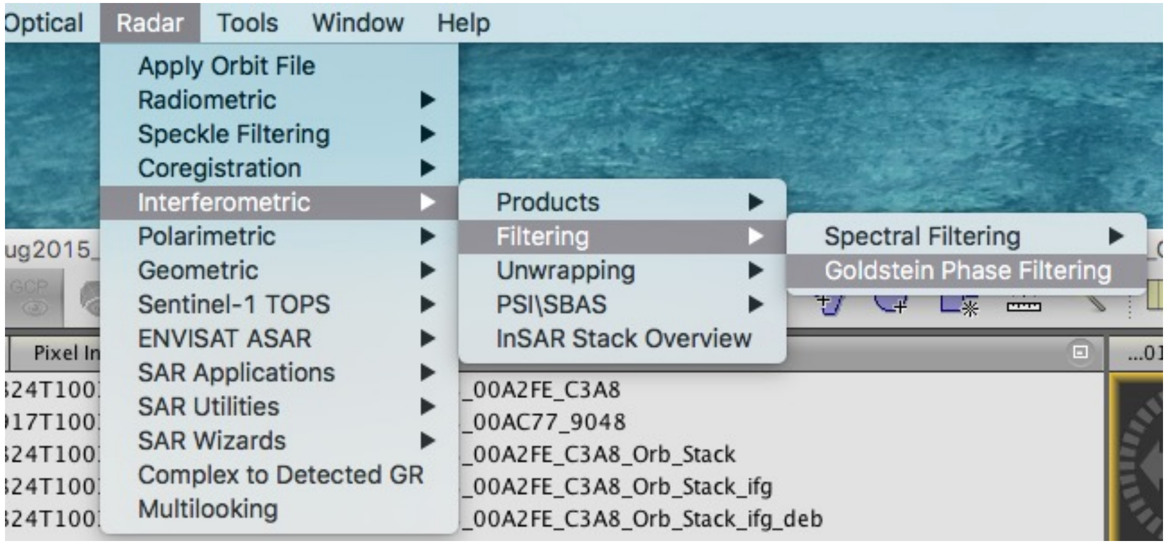
# Differential Interferometry

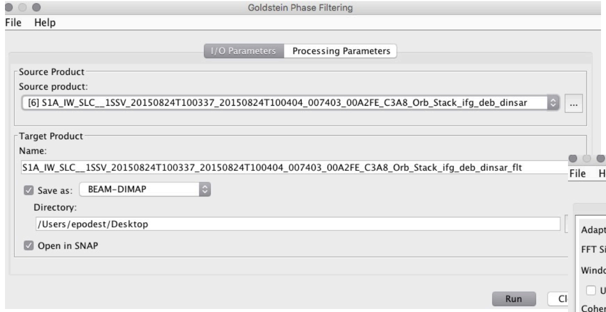
- Display the results. Note that the phase shows actual deformation due to the earthquake. The fringes on the top of the image are due to deformation from the earthquake. The city of Santiago is at the bottom of the image, and it was not severely affected by the earthquake
- Note that the interferogram is still very noisy. There is a lot of speckle in the phase. Filtering can be done to make the phase easier to see

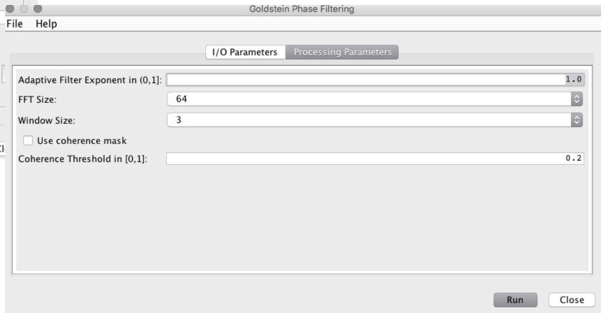


# Speckle Filtering

1. To filter the image, go to the main menu bar and select **Radar** > **Interferometric** > **Filtering** > **Goldstein Phase Filtering**
2. In the **I/O Parameters** tab, select the source as the _dinsar file. The target product is the output filename, which will have _flt at the end
3. In the **Processing Parameters** tab, use the defaults. The filter exponent can be higher if you wish for more filtering
4. Press **Run**

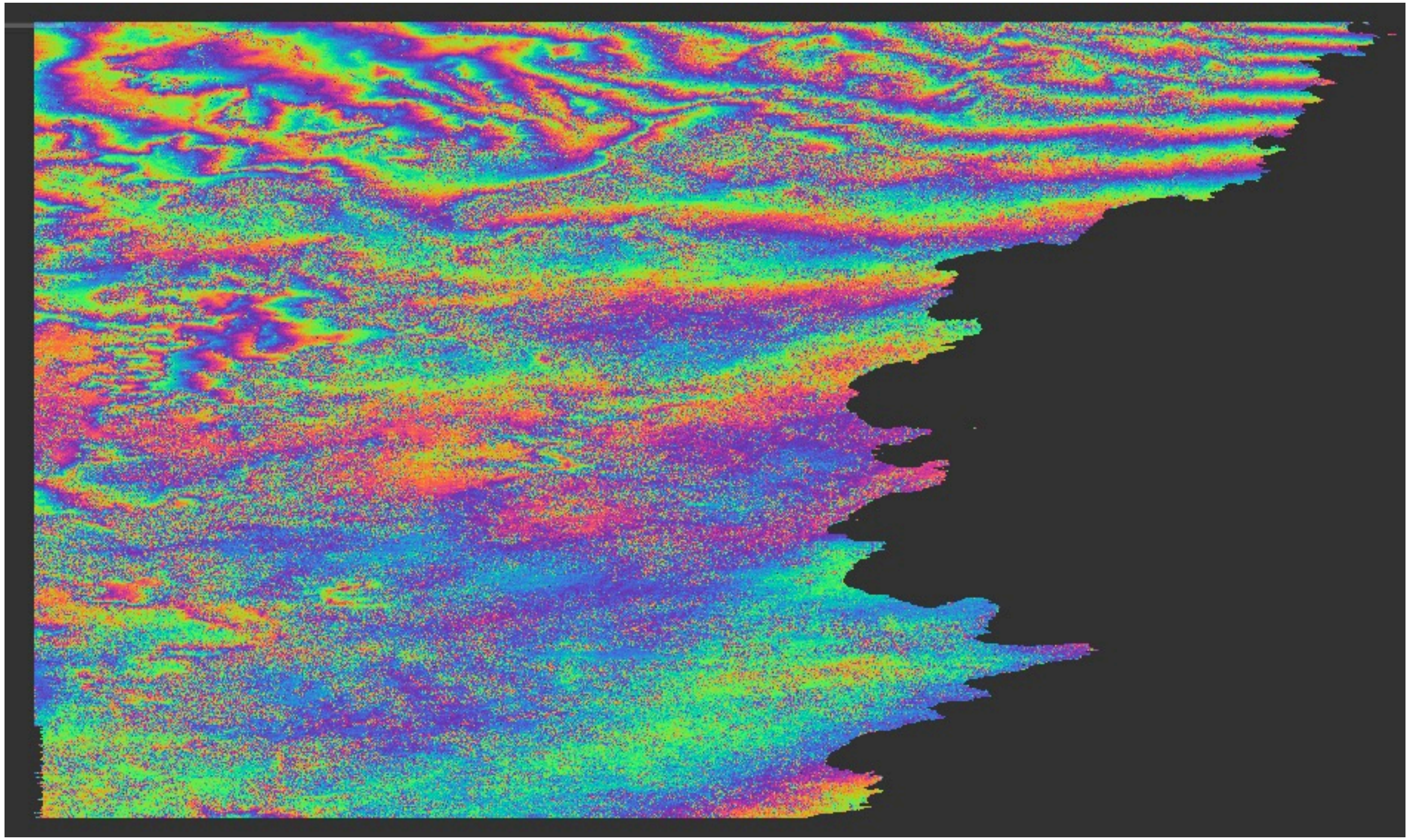


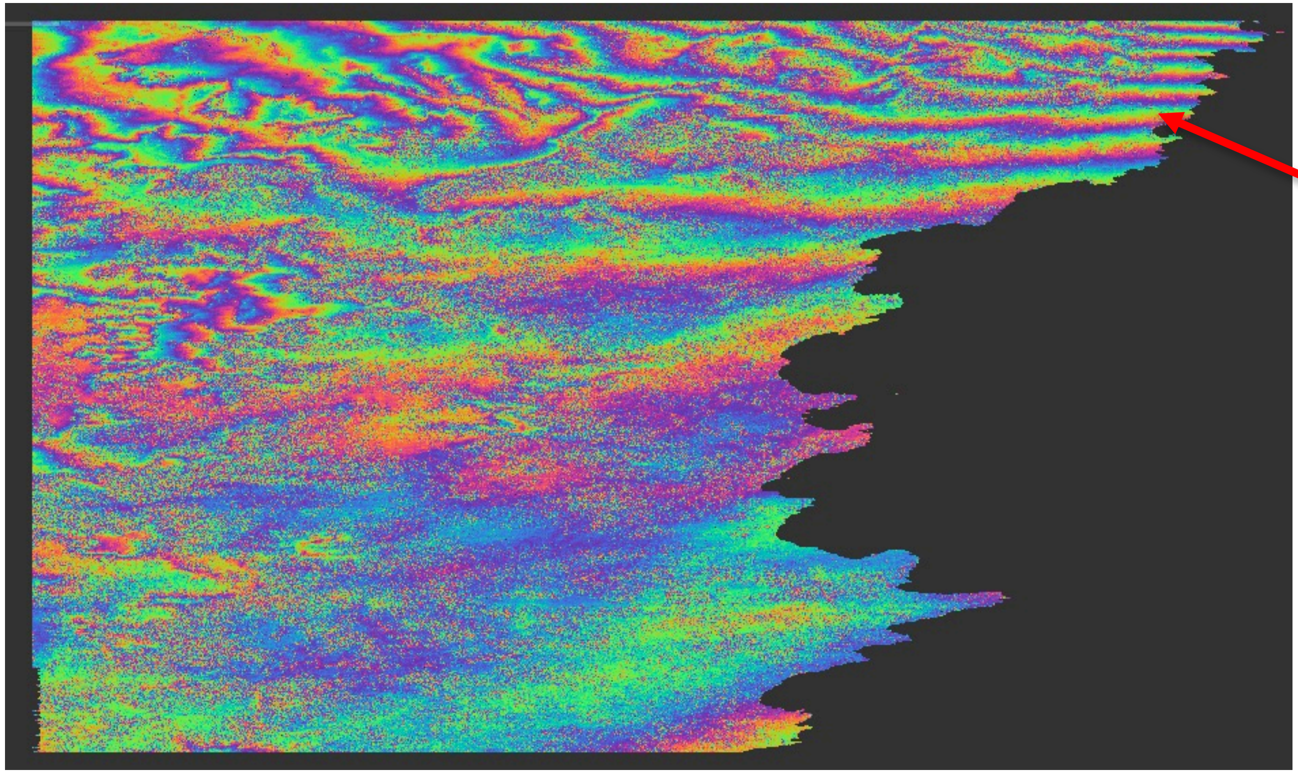
# Speckle Filtering

- The filtered phase looks much cleaner
- There are more fringes at the top, because that is where the earthquake hit.



# Results

- Each fringe is 4pi/wavelength * surface deformation
- Each fringe is about 3 cm, and there are a total of 10 fringes, making a total of 30 cm of deformation as a result of the earthquake



fringe